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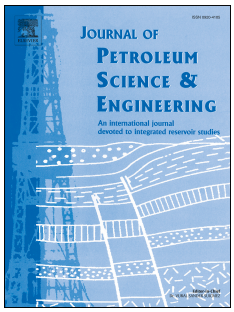

A unified transient solid-liquid two-phase flow model for cuttings transport- modelling part

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A unified transient solid-liquid two-phase flow model for cuttings transport- modelling part

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Abstract

A unified transient model is presented for predictions of flow pattern transitions, pressure gradient, solid particle concentration in solid-liquid two-phase flow. The transient mechanistic model is based on the conservation of mass and momentum and coupled with flow pattern prediction methods. Changes of flow patterns are reflected by assigning certain terms to zeros in the general equations and changing the number of equations. Thus, the model can be automatically adjusted for flow patterns in transient simulation.

A semi-implicit approach is used to solve the model. The velocities and pressures are solved implicitly based on the momentum conservation equations and the solids concentrations are updated explicitly based on the mass conservation equations.

The model is validated by conducting a series of experimental tests on a full scale flow loop (0.2 ×0.11×25 m). The validation of the transient simulation includes the validation of the transient build-up stage and the validation of the cuttings volumetric concentration at fully developed stage. Results found that increase of the flow rate significantly reduces the build-up time, and effects of pipe rotation vary at different inclined angles. The effect of inclination angle on solids profile build-up is similar to the effects of well inclination angle on steady state cuttings concentration. Below 60 degrees, the build-up time increases significantly as the well inclination angle increases. When the well inclination angle goes to over 60 degrees, the effects of well inclination angle become insignificant.

1 Introduction

Cuttings transport is one of the major challenges in drilling, especially for extended reach drilling (ERD). Hole cleaning in vertical wells has been well studied. However, hole cleaning and other problems related to insufficient hole cleaning in deviated and horizontal wells, especially wells with long deviated laterals, is still a major drilling challenge. In deviated wells, the flow rates required to avoid the formation of cuttings beds are usually too high and can easily cause other problems (Li and Luft 2014; Zhang 2015; He et al. 2016), such as high ECD and wellbore-stability issues. For these scenarios, a certain amount of cuttings beds is acceptable during the drilling of deviated wells, and the major restrictions on the cuttings